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Los Alamos
National Laboratory

Environmental, Safety, Health Directorate

Environmental Protection and Compliance (EPC) Division

Environmental Compliance Programs

Technical Project Plan

for

Meteorological Monitoring

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0	9/12/07	Revised, updated, and reformatted. Assigned Revision 0 by the Document Control Coordinator. Supersedes RRES-MAQ-MET, R8, Quality Assurance Project Plan for the Meteorological Monitoring Project.
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1	9/14	Revised to include specific regulatory drivers for the meteorology project, user performed calibration plan, updated tower/instrument locations.
EPC-CP-TPP-MetM R2	05/19/2016	Revised to address DMCC comments, add instrument uncertainties, update organizational elements, and update references. This document supersedes ENV-PLAN-300 R1. A new document # has been assigned.

Contents

1.0 INTRODUCTION

This Technical Project Plan (TPP) specifies how the Los Alamos National Laboratory (LANL) Meteorology Monitoring Project implements the quality and technical activities defined by Department of Energy (DOE) orders and State and Federal regulations. The quality and technical requirements for meteorological monitoring are specified by DOE Order 414.1d Quality Assurance, Environmental Protection Agency (EPA) Guidance for Quality Assurance Project Plans (EPA 2002), and ANSI Standard 3.11 Determining Meteorological Information at Nuclear Facilities. The TPP will be reviewed annually and revised as necessary.

2.0 LANL METEOROLOGICAL PROJECT DESCRIPTION

The purpose of the Meteorology Monitoring Project is to provide all routine meteorology measurements required by LANL to meet DOE orders and State and Federal regulations.

The LANL Meteorology Project is part of the Environmental Protection and Compliance (EPC) Division. The EPC Division provides environmental expertise to LANL. The primary customers of the Meteorology Project are the LANL Emergency Operations Center; LANL operating facilities; LANL Utilities and Infrastructure Division; EPC Division; the Environment, Safety, Health Associate Directorate (ADESH); and LANL research programs (see Appendix D).

2.1 Regulatory Drivers

The following DOE orders and regulatory requirements describe the rationale and requirements for meteorological monitoring projects at LANL. References are included in section 10.0.

On-site meteorological data are required for use in atmospheric dispersion modeling applications. Specific regulations requiring LANL to perform atmospheric dispersion modeling include:

- the federal Clean Air Act for radionuclide air emissions (40 Code of Federal Regulations [CFR] 61 Subpart H, National Emissions Standards for Hazardous Air Pollutants – Radionuclides) for pre-construction approval for sources of air emissions and annual documentation of off-site radiological doses,
- the New Mexico regulations for non-radioactive air emissions (20.2.70 New Mexico Administrative Code [NMAC] Title V Operating Permit for LANL non-radionuclide air emissions) for pre-construction approval for sources of air emissions,
- the federal Nuclear Safety Management (10 CFR 830) for determining worst case ***meteorology*** conditions for accidental releases from nuclear facilities,
- the New Mexico regulations for the LANL Hazardous Waste Facility Permit (RCRA) for determining downwind air concentrations of specific waste treatment units,
- the DOE Order for Comprehensive Emergency Management System (DOE Order 151.1C) for performing real time impact assessments of potential LANL unplanned releases of toxic or radioactive materials, and
- the DOE Order on Radiation Protection of the Public and the Environment (DOE Order 458.1) for calculating radiation doses to members of the public.

A wide variety of meteorological measurements, such as temperature, pressure, relative humidity, and rainfall, are required to support other regulatory compliance programs and LANL operational requirements. These programs include:

- The LANL effluent discharge permits (National Pollutant Discharge Elimination System permits for stormwater, construction sites, and general sources) require routine on-site rainfall and temperature monitoring.
- DOE/New Mexico Environment Department (NMED) Consent Order uses meteorology data as part of site characterization projects.
- LANL Site-wide Environmental Impact Statement and environmental assessments require meteorology data for facility assessments.
- LANL engineering design standards require meteorology data (rainfall, snowfall, temperature, dew point temperature, etc.) for building and road designs.
- Occupational Safety and Health Administration (OSHA) safety requirements (wind speed, temperature, rainfall) for identifying safe working conditions and required personal protective equipment.

A wide variety of meteorological measurements are also used in the analysis of LANL research and experiments. These data include pressure, temperature, solar radiation, and relative humidity.

Guidance documents providing the technical requirements on instrumentation, sampling, siting, data processing, and quality assurance include:

- ANSI/ANS-3.11-2015 “Determining Meteorological Information at Nuclear Facilities,”
- EPA-454-99-005 “Meteorological Monitoring Guidance for Regulatory Modeling Applications,” and
- DOE-HDBK-1216-2015, DOE Handbook, “Environmental Radiological Effluent Monitoring and Environmental Surveillance.”

2.2 Facilities and Instrumentation

A network of five towers gathers meteorological data. Four of the towers are located on mesa tops (Technical Area [TA] 6, TA-49, TA-53, and TA-54) and one is in a canyon (TA-5 Mortandad). The TA-41 tower was retired in 2015 due to malfunctioning of the tower telescoping mechanism and the lack of any LANL emissions or accident source terms located in Los Alamos Canyon. The TA-6 tower is the official meteorological measurement site for LANL and the town of Los Alamos. The TA-54 tower is the official meteorological measurement site for the town of White Rock. A sound detection and ranging (SODAR) instrument is located adjacent to the TA-6 meteorological tower. One additional precipitation measurement location is operated in conjunction with Los Alamos County staff in the North Community neighborhood of Los Alamos.

The following table lists procedures that will be followed for maintenance of the instrument network.

Procedure Identifier	Title
ENV-CP-SOP-5131	Calibration and Maintenance of Instruments for the Meteorology Monitoring Project
ENV-MAQ-404	Repairing, Maintaining, and Calibrating Meteorological Instruments in the Field
EP-ERSS-SOP-5100	Meteorological Tower Hoist Operation

Procedure Identifier	Title
EPC-CP-SOP-405	Meteorology Tower Site Inspections

Figure 1 shows the locations of the Meteorology stations. An abundance of detail on the instrumentation can be found in LA-UR-14-23378, “Meteorological Monitoring at Los Alamos,” which can be downloaded from the LANL library or from the Weather Machine website.

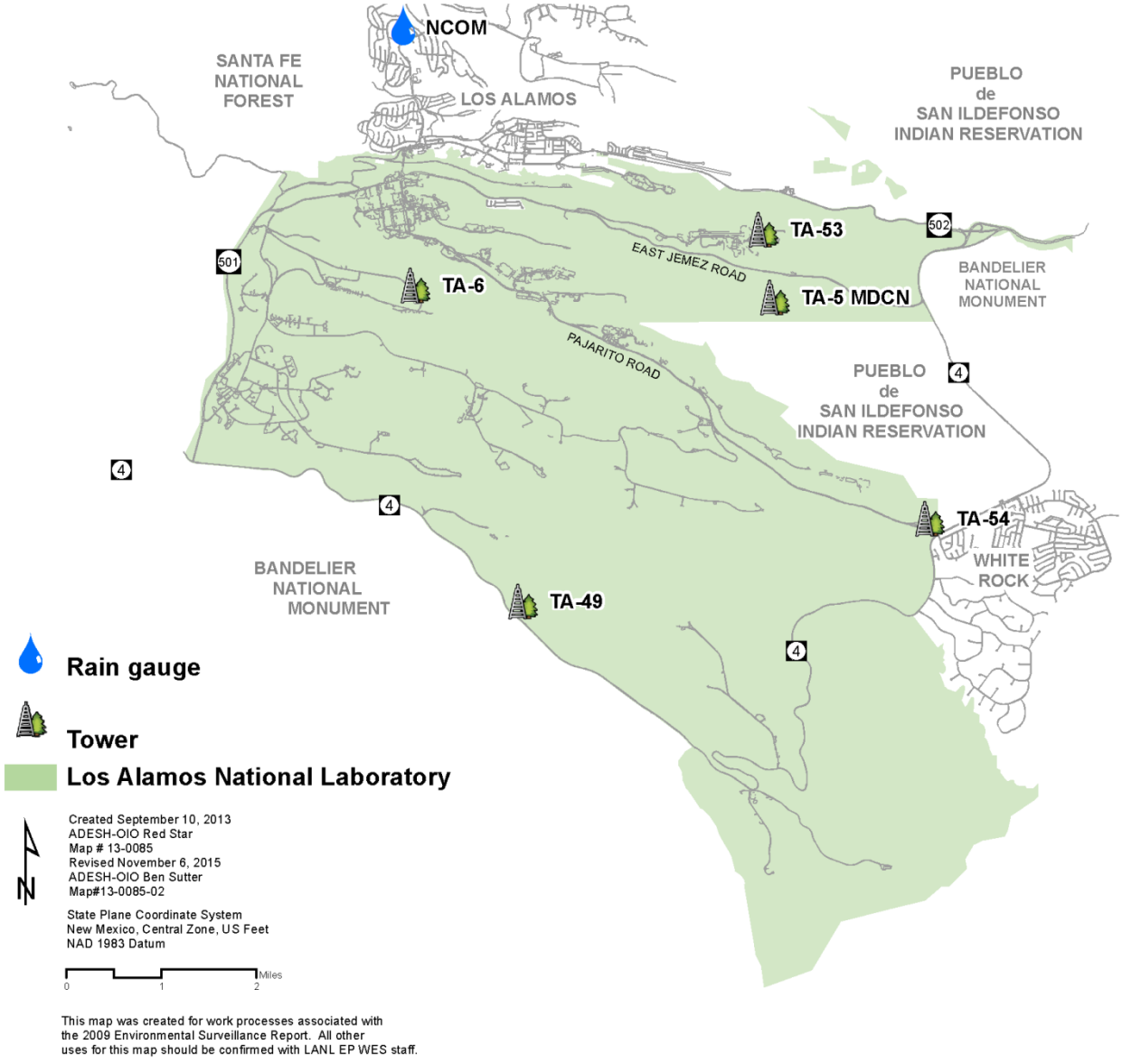

Figure 1. Map of Meteorological Towers at LANL.

With the exception of the TA-5 Mortandad Canyon station, all elevated instruments are supported by towers of open-lattice construction with instruments mounted on booms. To reduce flow distortion by the tower, booms face south through westward into the prevailing wind and boom lengths are more than twice the tower width. The booms at the four mesa-top towers are attached to an elevator system; the booms are lowered to the ground by a hoist motor for instrumentation inspection and replacement.

The TA-5 Mortandad Canyon tower is a 10-meter tower composed of a moveable post mounted on a fixed tripod. The post is mounted on a hinge and can be lowered from the vertical position to a horizontal position by hand. But as with other towers, elevated measurements are taken at a distance from the tower of more than twice the tower width, and the tower itself is leeward to the instruments.

2.3 The Weather Machine at LANL

The LANL Meteorological Project distributes data and information to many customers from its website, known as the LANL Weather Machine at http://weather.lanl.gov/ internally and http://www.weather.lanl.gov/ for users external to the LANL yellow network. The website provides details and specifications of the instrument network, current and recent conditions around Los Alamos, current regional and national weather conditions, weather forecast products, local climatological information, local meteorological data, and air quality model input data sets.

The website's Data Requests section provides a series of web forms for automated data requests, enabling customers to download archived data for use in various projects. Users can also download special meteorological data sets for running some of the more common air dispersion and dose assessment models, which may be used for air permitting or demonstrating regulatory compliance. The meteorological data are pre-formatted for the intended model, requiring minimal additional processing by the user.

Customer feedback: users of the meteorological data contact Meteorology Project personnel with questions and problems concerning the data and tools provided by the Project at weather@lanl.gov.

The **Table of Measured Meteorological Variables** below lists the variables that are measured at the various tower locations, along with the height of the measurement above ground level in meters, marked by a ✓. Most towers are instrumented at several levels.

Table of Measured Meteorological Variables

Height (m)	Wind						Atmospheric State							Radiative Fluxes			
	u	σ_u	θ	σ_θ	w	σ_w	T	p	h	T_d	r	s_d	s_f	K↓	K↑	L↓	L↑
TA-6 (Official Los Alamos weather station)																	
1.2							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11.5	✓	✓	✓	✓	✓	✓	✓										
23.0	✓	✓	✓	✓	✓	✓	✓										
46.0	✓	✓	✓	✓	✓	✓	✓										
92.0	✓	✓	✓	✓	✓	✓	✓										

Height (m)	Wind						Atmospheric State							Radiative Fluxes			
	u	σ_u	θ	σ_θ	w	σ_w	T	p	h	T_d	r	s_d	s_f	K↓	K↑	L↓	L↑
TA-54 (Official White Rock weather station)																	
1.2							✓	✓	✓	✓	✓			✓	✓	✓	✓
11.5	✓	✓	✓	✓	✓	✓	✓										
23.0	✓	✓	✓	✓	✓	✓	✓										
46.0	✓	✓	✓	✓	✓	✓	✓										
TA-49 (Bandelier)																	
1.2							✓	✓	✓	✓				✓			
11.5	✓	✓	✓	✓	✓	✓	✓										
23.0	✓	✓	✓	✓	✓	✓	✓										
46.0	✓	✓	✓	✓	✓	✓	✓										
TA-53 (Neutron Scattering Science Center)																	
1.2							✓		✓	✓	✓			✓			
11.5	✓	✓	✓	✓	✓	✓	✓										
23.0	✓	✓	✓	✓	✓	✓	✓										
46.0	✓	✓	✓	✓	✓	✓	✓										
TA-5 (Mortandad Canyon)																	
1.2							✓							✓			
10.0	✓	✓	✓	✓	✓	✓	✓										
North Community																	
1.2											✓						

LEGEND:

u	σ_u	θ	σ_θ	w	σ_w	T	p	h	T_d	r	s_d	s_f	K↓	K↑	L↓	L↑

u = horizontal wind speed (Align Table Columns & fix symbols below to match above)
σu = standard deviation of horizontal wind speed
θ = wind direction
σθ = standard deviation of wind direction
w = vertical speed
σw = standard deviation of vertical speed
T = temperature
p = pressure
h = humidity
Td = dew point temperature
r = rainfall
Sd = snow depth
Sf = snowfall
K↓ incoming solar radiation
K↑ outgoing solar radiation
L↓ incoming long wave radiation
L↑ outgoing long wave radiation

Ten-hour fuel moisture and fuel temperature are measured at the ground surface at TA-6. These measurements are designated as W_{10} and T_{fuel}. The one-hour fuel moisture is calculated based on the ten-hour value, incoming solar radiation, and ambient relative humidity. This calculation is performed and documented in the TA-6 datalogger.

3.0 ORGANIZATION AND RESPONSIBILITIES

Figure 2 identifies LANL organizations and functions that the Meteorology Project supports or that support the Meteorology Project. The EPC Meteorology Project is responsible for:

- maintaining calibrated instrumentation and quality assured data to support regulatory compliance, DOE order compliance, and operational needs,
- providing data analysis and weather forecasting support to LANL operations, and
- providing emergency response dispersion modeling and weather forecasting.

The overall meteorology data management system is under the direction of the Operations Integration Office (OIO). OIO provides (or coordinates with other divisions to provide):

- project management for initiatives modifying software programs, database operations and design, and network processes operating on LANL's network
- computer system administration
- data management server
- meteorology tower dial-up PC security
- database management system and documentation
- routine meteorology data processing and graphic display programs and documentation

- routine automated meteorology data delivery to emergency response and National Weather Service customers
- web server providing meteorology data to internal LANL customers
- web server providing meteorology data to external LANL customers

The OIO works closely with Meteorology Project staff to ensure data delivery to customers. OIO and EPC-DO set priorities for funding, staffing, and implementing the meteorology data management system.

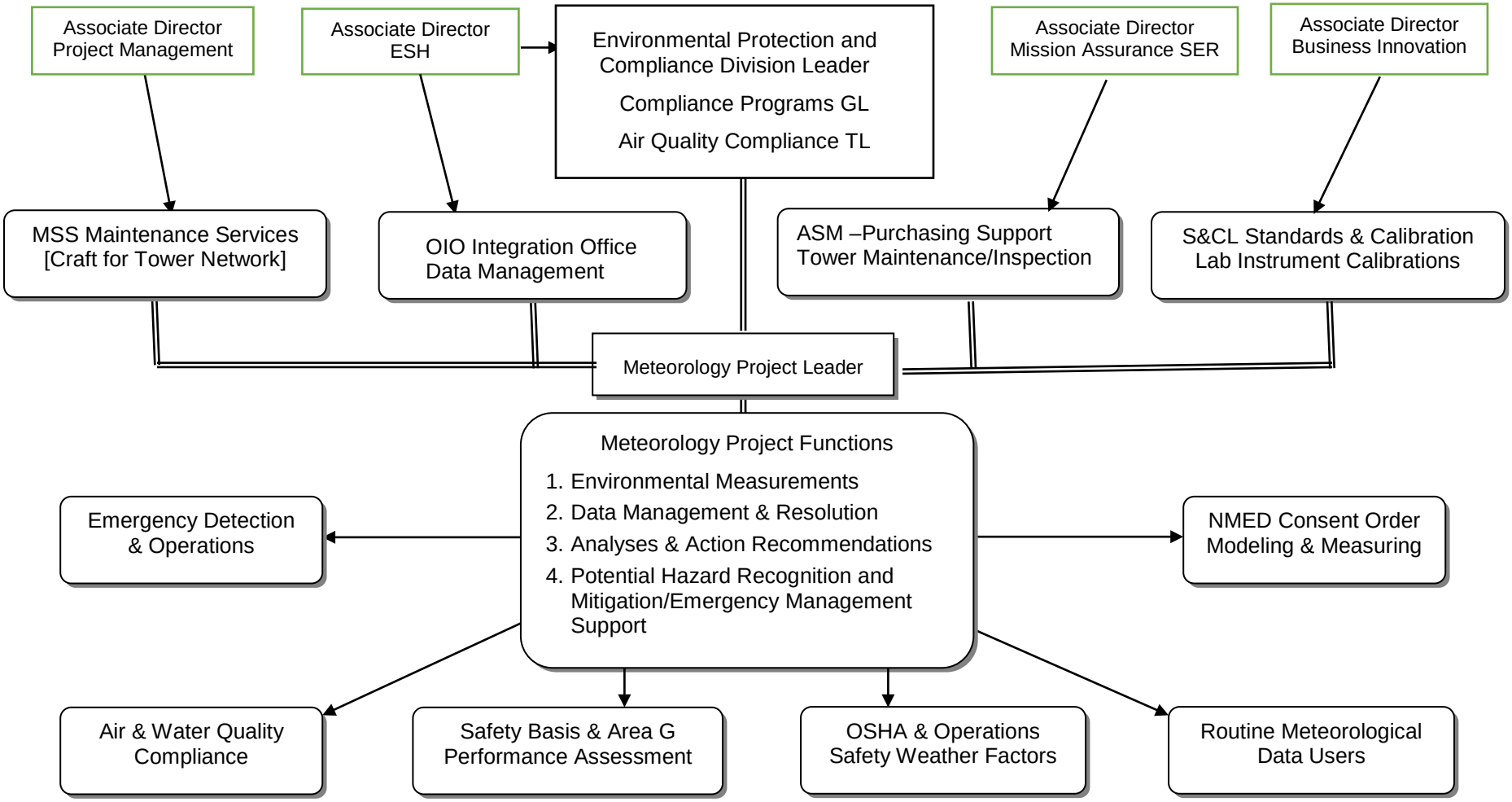

Figure 2. LANL Meteorological Project Organization Chart

The Maintenance and Site Services (MSS) Division is responsible for administering the subcontract for tower maintenance and repair and providing hoist inspections. MSS Division also provides electrician, road maintenance, and other craft services to the Meteorology Project.

The LANL Standards and Calibration Laboratory (SCL) is responsible for the calibration of

- meteorology calibration standards;
- humidity, pressure, and solar radiation instruments; and
- review/approval of the Meteorology Project User Calibration Plan (Appendix A of this document).

SCL either calibrates meteorology standards and instruments or sends them to vendors who are qualified to do so. SCL maintains the records for equipment they calibrate or send out.

The Meteorology Project is responsible for operational meteorological monitoring at LANL and is funded primarily by LANL General and Administrative funding. Day-to-day management of the Meteorology Project is the responsibility of the Meteorologist, who reports to the Compliance Programs Group (EPC-CP) line management.

The Meteorology Project's work can be divided into four broad components: measurements, data management, analysis, and support of emergency management. Work in these four components can be considered either *base work* or *quality improvement work*. Base work is continuous, routine work essential to providing customers with basic services.

Quality improvement work consists of short-term projects designed to fix or improve some aspect of the Project. Work assignments include base work plus quality improvement projects as time allows. The base work responsibilities of Meteorology Project members are provided in the table below.

Meteorology Project Worker Title	Meteorology Project Base Responsibilities
LANL Meteorological Project Leader	Primary responsibility for implementing the LANL Meteorology Project.
Meteorologists	Plan, coordinate, and participate in programmatic work; oversee quality assurance; ensure goals are achieved in a cost-effective manner; submit budget performance data to upper management; handle data requests and conduct meteorological analyses; make data quality decisions; maintain plume modeling skills; support the Emergency Operations Center; forecast weather. Assure that the subcontract for tower inspection, maintenance, and repair is implemented.
Meteorology Instrument Technician	Maintain the measurement network including procurement, acceptance testing, installation, calibrations, inspections, data logger programming, and documentation; assist with data quality control activities.
Meteorology Data Steward	Overall responsibility for routine data processing. Assure that up-to-date meteorology measurements are delivered to the web and to customers. Perform data quality updates, maintain software support contracts, perform data processing and backups, and provide PC support. Responsible for meteorology tower datalogger programming aspects related to data transfer to met tower dial PC. Responsible for datalogger communications software installed on the met tower dial PC. Provide subject matter expertise in meteorology data processing to OIO staff.

4.0 PERSONNEL TRAINING AND QUALIFICATIONS

Meteorology Project personnel are selected through an extensive process aimed at ensuring sufficient training and qualification.

4.1 Personnel Training

Personnel training is on-going as personnel annually review LANL and EPC Division-wide training requirements and all project-specific procedures applicable to their job assignments.

Staff is encouraged to continue training and education in their individual areas of expertise; formal training and self-study in meteorology, instrumentation, and computer science are especially relevant to programmatic work. In addition to on-site training offered through LANL, attendance at professional meetings is encouraged to the extent the budget and time allow.

4.2 Personnel Qualifications

The table below summarizes necessary qualifications, mix of skills, and level of proficiency required by programmatic work.

Meteorologists	Should have a graduate degree in meteorology. A substantial research background is also necessary to be fully effective in assisting LANL personnel with a wide variety of analyses. Should also have electromechanical and computer programming experience in order to effectively oversee all aspects of the Project. LANL electrical safety and first aid/CPR training are required to fulfill work responsibilities. Other specific training is designated in procedures and Integrated Work Documents (IWDs).
Meteorology Instrument Technician	Must be an accomplished electromechanical technician with formal training in electronics and several years of experience. Good understanding of meteorological sensors, data loggers, transmitters and general principles of engineering, measurement science, calibration and testing is also necessary. Should be an independent worker with strong problem-solving skills. LANL R&D electrical worker and first aid/CPR training are required to fulfill work responsibilities. Serve as person-in-charge for meteorology instrument calibrations and tower instrument change-out/maintenance. Other specific training is designated in procedures and IWDs.
Meteorology Data Steward	Should have experience in system administration tools and processes plus a good working knowledge of UNIX and Windows commands and utilities. Should be proficient with datalogger protocols for transferring data to the met tower dial PC. Should be proficient at data processing. Specific training is designated in procedures and IWDs.

5.0 QUALITY IMPROVEMENT

LANL-wide guidance on quality improvement is provided by the LANL Procedure P322-4 “Laboratory Performance Feedback and Improvement Process.”

Within the Meteorology Project, several processes are pursued to detect and prevent quality problems, and to improve Meteorology Project data accuracy.

- Both manual and automated data checks are performed by the meteorologists and the Meteorology Instrument Technicians. These ongoing data checks are further described in section 8.9, Internal Quality Control, of this document.
- Routine calibration and maintenance of instruments: the Meteorology Instrument Technician implements the meteorology instrument calibration program outlined in Appendix A. Instruments that do not meet calibration requirements are taken out of service or rebuilt to meet requirements.
- Annual inspection and maintenance of meteorology towers and hoists: a subcontractor specializing in tower inspection and maintenance inspects all towers annually and performs routine maintenance as required. The LANL hoist program conducts the annual instrument boom hoist inspection in conjunction with the tower maintenance subcontractor visit to assure correct operation and maintenance of the instrument boom hoists.
- Management Updates: the Meteorology Project Leader regularly updates line management on data quality issues and administrative topics such as budget and activities. Meetings are held with EPC-CP group managers weekly. Quarterly meetings with the Environmental Protection and Compliance Division Leader are held quarterly. Beginning in calendar year (CY) 2013, the meteorologist has written an annual review of data quality; this report is submitted to management and made available to customers through the Weather Machine web page.
- Annually, the meteorologists review data completeness and data quality issues. An annual report is prepared to assure that project requirements have been met and to document issues and resolutions. The most recent reports are:
    - LANL Meteorology Monitoring Project: 2013 Data Completeness/Quality Report (LA-UR-14-2114)
    - LANL Meteorology Monitoring Project: 2014 Data Completeness/Quality Report (LA-UR-15-21184)
- Customer feedback: users of the meteorological data contact Meteorology Project personnel with questions and problems concerning the data and tools provided by the Project at weather@lanl.gov.
- Internal assessments: An internal assessment of the meteorology calibration procedure was conducted in 2013 (OIO-13-001). Beginning in CY2016, the meteorologist will document a review of the Meteorology Project using the DOE Meteorological Coordinating Council (DMCC) Meteorological Monitoring Project Self-Assessment Tool http://orise.orau.gov/emi/dmcc/files/2011DMCCAssessmentTool.pdf This assessment will be submitted to management with proposed corrective actions.
- Independent assessment: audits provide a fully independent source of quality control. In fiscal year (FY) 2015, the DOE Meteorology Coordinating Council provided a review of the LANL Meteorology Project as part of their assist visit program (DMCC 2015). Specific recommendations were made and plans to implement these have been submitted to EPC Division management. Independent assessments are further addressed in section 9, Assessments and Reports to Management.

6.0 DOCUMENT CONTROL AND RECORDS MANAGEMENT

The Meteorology Project will follow ADESH and EPC Division procedures that prescribe prominent and safety related work only through current, management-approved instructions, procedures, and drawings.

The Meteorology Project will maintain formal documentation that records the work and the results of Meteorological Project implementation. The documents include the Technical Project Plan for Meteorological Monitoring (this document) and implementing procedures. These plans and procedures are reviewed tri-annually for required improvements and updates.

The Project generates records of methods used, work completed, results of its measurement and analysis activities, and data quality. Electronic records are submitted and stored in the ADESH Electronic Document Management System (EDMS). Hardcopy records associated with the various project components are stored in the instrument lab (TA-54-1001) and at the Meteorology Project Leader's office.

7.0 PROCUREMENT

The Meteorology Project procures critical items and services in accordance with the LANL policies and procedures for procurement. Specifications have been established that meet or exceed quality and technical requirements. Equipment and instrumentation that meet specifications are acquired. Industrial commercially available equipment is evaluated against these specifications and only appropriately qualified and proven equipment is utilized. The Meteorology Project follows LANL-wide guidance on procurement as provided by the LANL Implementation Support Document ISD 840-1.1 "Procurement Quality."

The Meteorology Project procures equipment and services from reputable vendors recognized for their quality through years of experience. For example, many of our instruments are purchased from Campbell Scientific, RM Young, and MetOne, vendors within the meteorology community with high quality, advanced grade operational weather observation instrumentation. Because of well-established relationships with vendors, the Meteorological Project Team is able to ensure that instrumentation and systems operate as they should; vendors are quick to correct problems such as defects with the interest of maintaining the relationship. We have also been flexible enough to change vendors when warranted. Instrumentation and equipment specifications, compliance inspections, calibrations, and tests are consistently conducted, documented, monitored and items are fixed or replaced when needed.

The Meteorology Instrument Technician maintains a spare parts inventory for all project instrumentation, equipment, and consumable supplies. This list is reviewed periodically and spare parts, equipment, and supplies are ordered to assure that materials are available when needed.

8.0 WORK PROCESSES

This section documents the technical and quality requirements specific to the LANL Meteorology Monitoring Project. Specific technical requirements are taken from regulatory requirements listed in section 2.1, Regulatory Drivers.

8.1 Design Control

The basic elements of the Meteorology Project, including standard meteorological measurements, plume calculations, and data storage, were initially designed to meet the basic monitoring requirements set forth in the DOE orders. Over the years these elements have been continually refined to reflect advances in technology, to reflect changes in ideas of what is acceptable and defensible, and to meet the increasing demand for meteorological information. For example, the internet has been utilized to make this

meteorological information readily available to the LANL community with the development of the Project's website “The Weather Machine” (see http://weather.lanl.gov). (Refer to section 2.3.)

General design criteria and considerations are listed in the table below.

Element	Design Requirement
Instrumentation	Must be capable of continuous operation in all weather conditions and meet DOE requirements for accuracy.
Computer systems	Must handle computation- and graphics-intensive applications in a secure and reliable manner.
Station network	Must adequately measure the variance in all important meteorological variables across a large site with complex terrain.
Archive	Must be accessible and contain useful and accurate data.
Automation	Must improve overall quality and cost effectiveness.

Specific tower instrumentation is used in the following applications

Instrument	Design Requirement
horizontal/vertical wind speed, direction	15-minute average data to support emergency response plume modeling, annual average dispersion modeling for regulatory compliance, OSHA safety requirements for crane work, prediction of noise from high explosives tests, weather forecasting, and support for research experiments. Longer-term averages to support engineering design.
temperature	15-minute average data to support emergency response plume modeling and weather forecasting. Annual averages, maximum/minimum data for engineering design, and support for research experiments.
relative humidity	15-minute data to support research experiments and weather forecasting. Annual averages and maximum/minimum data for engineering design.
pressure	15-minute data to support emergency response plume modeling, groundwater level measurements, weather forecasting, and support of research experiments.
solar radiation	15-minute data to support emergency response plume modeling. Daily average data to support alternative energy and building energy conservation.
precipitation	15-minute data to support National Pollutant Discharge Elimination System (NPDES) permits, weather forecasting, and engineering design. Longer-term averages for engineering design.
fuel moisture	15-minute and longer-term averages to support estimates of wildland fire danger.

8.2 Data Quality Assurance Objectives

Following the DOE orders and regulatory requirements listed in section 2.1, the LANL Meteorology Project, has two main objectives: (1) provide general meteorological support for LANL regulatory compliance activities, emergency response, operations, hazards assessment, safety analysis, environmental studies,

experiments, etc. and (2) maintain expertise in weather forecasting and airborne plume modeling capability for the LANL Emergency Management System.

8.2.1 General Meteorological Support

As described in section 2, general meteorological support spans a broad range of LANL projects and programs. Site-specific meteorological data are routinely required for demonstrating regulatory compliance in the areas of air quality, water quality, waste management, as well as supporting monitoring programs in biology, hydrology, and health physics, to name a few applications.

To meet this objective, continuous measurement of wind, temperature, humidity, dew point temperature, pressure, shortwave and long wave radiation, and precipitation are performed, quality-controlled, archived, and made accessible through the Weather Machine (http://weather.lanl.gov).

The project staff assists customers with meteorological data analysis and interpretation. The project provides support to LANL operations coordinators with forecasts and analyses if future weather conditions may adversely affect safe operations at, and travel around, LANL (e.g., snow, heavy rain, or lightning).

8.2.2 Airborne Plume Modeling

The Meteorology Project provides data and expertise to assist Emergency Operations in the calculation of potential radiological or toxicological hazards in the event of an unplanned release of hazardous materials to the atmosphere. These calculations require meteorological conditions including wind speed and direction, standard deviation of wind direction and other indicators of stability class, temperature, and precipitation. Meteorology data are delivered to the Emergency Operations Center and to the National Atmospheric Release Advisory Capability (NARAC) in near real-time to support emergency response. Results of the calculations are used to classify the incident, and the incident classification leads to decisions regarding the LANL response.

The meteorologists train on and use various atmospheric dispersion modeling codes to support Emergency Operations, including NARAC, Hotspot, EPICode, and CAPARS.

8.2.3 Measurements and Accuracy

To serve the broad range of meteorological applications, it is necessary to measure a comprehensive set of variables at multiple locations. It is also necessary to operate stations at the upper and lower elevations of the site due to the significant change in elevation across LANL. Many weather variables are listed in section 2.2. The most critical variables, arguably, are those associated with atmospheric dispersion modeling to support regulatory requirements and emergency management including wind speed and direction, a stability indicator (such as standard deviation of wind direction), temperature, precipitation, and humidity. Clearly, however, there is demand for a very broad range of additional variables including, for example, solar and infrared radiation, and pressure.

Customers generally do not provide specific requirements concerning the level of accuracy or precision of the measurements that they use. Therefore, a formal DQO (Data Quality Objectives) analysis, in which the importance of each variable is gauged along with required accuracy, is impractical to perform since it requires input on data and accuracy from so many customers. DOE (2015) has directed that the accuracies of the monitoring measurements should be consistent with the specifications set forth in either ANSI/ANS-3.11-2015 or EPA-454R/R-99-005.

A complete list of variables that we measure is presented below, along with our instrumental accuracy and the system accuracy requirement. In every case except for dew point temperature, the instrument

accuracy of our measurements matches or exceeds the DOE standard for system accuracy. However, dew point temperature is derived from temperature and relative humidity. Simple calculations of dew point temperature versus small changes in the dependent variables show that the error obeys the ±1.5 degree limit except where temperature is very high and humidity is very low. Thus, the ±1.5 degree limit is mostly satisfied.

System accuracy is dominated by instrument uncertainty. Uncertainties introduced by system components such as the datalogger and data management system are typically small. A demonstration of the adequacy of the project calibration equipment for temperature and wind measurements is presented in Appendix A, User Performed Calibration for the Meteorology Monitoring Project. Demonstration of the total system accuracy for each instrument is presented in Appendix C, Meteorology System Accuracy Documentation, following the specifications in DOE (2015).

Measured Parameter	Units	Instrument* Accuracy (±)	DOE (2015) System Accuracy Requirement (±)
Wind speed (u)	meters per second	0.2*	*0.22 m/sec for speeds less than 2.2 m/sec Within 5% for speeds equal to or greater than 2.2 m/sec
Standard Deviation of Wind Speed (σ_u)	meters per second	n/a	n/a
Wind Direction (θ)	degrees azimuth	3	5
Standard Deviation of Wind Direction (σ_θ)	degrees azimuth	n/a	n/a
Vertical Wind Speed (w)	meters per second	0.25	n/a
Standard Deviation of Vertical Wind Speed (σ_w)	meters per second	n/a	n/a
Temperature (T)	degrees Celsius	0.19	0.5
Barometric Pressure (p)	millibars	0.55	3
Relative Humidity (h)	percent	1.5	4
Dew point Temperature (T_d)	degrees Celsius	3.3	1.5
Precipitation (r)	inches	0.0025	0.01
Snow Depth (s_d)	inches	0.4	n/a
Snowfall (s_f)	inches	0.4	n/a
Temperature of 10-hour fuel stick	degrees Celsius	n/a	n/a
10-hour Fine-dead Fuel Moisture (W_{10})	percent	n/a	n/a
Solar radiation (K↓, K↑)	Watts per square meter	2 (zenith angle 0–70°)	5 for <100 watts/m^2
Terrestrial Radiation (L↓, L↑)	Watts per square meter	1	5 for <100 watts/m^2

*Instrument accuracies provided by the manufacturers.

8.2.4 Precision

The Meteorology Project provides consistent precision measurements by the use of the same instrumentation for each variable, mounting each instrument in a similar manner on each tower, and through the same calibration program for each type of instrument. At this time, the program does not calculate the precision of our measurements through the use of side-by-side measurements. Due to the natural variability of the atmosphere, side-by-side measurements cannot easily distinguish between atmospheric variability and instrumentation variability.

8.2.5 Comparability

The comparability of measurements across the LANL meteorology tower network is assured through the use of one manufacturer for each type of instrument.

8.2.6 Representativeness

The LANL site Meteorology Project consists of four mesa-top tower locations, one canyon tower location, and one rain gage station located in the Los Alamos townsite (Figure 1). Because LANL facilities are located on the mesa tops, these towers provide representative data for almost all weather-related operational applications.

A study by Lee et al. (1994) evaluated the adequacy of the tower network for accidental releases impacting the Los Alamos townsite. The study modeled hypothetical particle trajectories from the Chemistry and Metallurgy Research building at TA-3, using a $1/r^2$ interpolated wind field driven by data from the four mesa top towers. The particle trajectories were then compared with trajectories using a wind field driven by data from an additional temporary tower erected north of the Los Alamos townsite.

The conclusion from the study was that the four mesa-top towers are representative and the benefits of adding an additional tower north of LANL in the Los Alamos townsite would not significantly improve plume modeling. Evacuation decisions by emergency managers would be carried out for entire neighborhoods of Los Alamos, so the additional detail gained from adding an additional mesa-top tower would not change the response strategy.

An additional study to further evaluate the accident dispersion meteorology at TA-54 and at TA-16 has been proposed to determine if additional meteorology towers are necessary to provide sufficiently conservative dispersion estimates under postulated accident conditions.

8.3 Inspection and Acceptance Testing

All instruments are inspected upon receipt to confirm they are in good condition and the correct number of instruments is received. All instruments are calibrated before installation. Calibration is addressed in section 8.5 of this document. The User Calibration Plan (Appendix A of this document) and procedure EPC-CP-SOP-5131 “Calibration and Maintenance of Instruments for the Meteorology Monitoring Project” covers instrument calibration in detail.

A number of inspections, automated and manual, are performed to ensure that the data are of good quality and that the instruments are functioning properly. Sections 8.8 and 8.9 describe these methods in detail.

When new instruments are installed in the field, the data are reviewed by the Meteorology Project Leader within one week to assure that the new instrument is functioning correctly. A new procedure is being developed in FY2016 to document this process. For selected instruments, the datalogger programs must

be updated when new instruments are installed. A new procedure is also being developed in FY2016 to document the process of updating datalogger programs and checking the results.

8.4 Sampling Procedures

Each instrument is sampled every 3 seconds, then averaged or summed to create a 15-minute average value or sum. The 3-second measurements are also stored in the datalogger and evaluated to create 24-hour averages, maximums, and minimums. This meets ANSI/ANS-3.11-2015 sampling frequency requirements and National Weather Service requirements for measuring peak wind gusts

8.5 Calibration Procedures and Frequency

The entire network undergoes periodic calibration inspections and refurbishment as required. The calibration frequency requirements are based on the manufacturer's specifications and on operational experience. As part of the refurbishment process, instruments are removed from towers and a post-monitoring calibration is performed to ensure that the instruments were functioning properly. The replacement instruments undergo a rigorous pre-monitoring calibration process to ensure proper future function. Some instrumentation requires calibration less frequently (e.g., solar radiation sensors); therefore, these are not included in the 1-year cycle.

Instrument	Calibration Frequency	Source of calibration frequency requirement
Wind speed Wind direction	6 months	6 months – based on ANSI/ANS-3.11-2015 guidance and operational experience
Temperature	annual	Manufacturer and LANL Operational Experience
Relative humidity	annual	Manufacturer and LANL Operational Experience
Pressure	annual	Manufacturer and LANL Operational Experience
Solar radiation	5 years	Manufacturer and LANL Operational Experience
Data loggers	3 years	Manufacturer and LANL Operational Experience

During 2013, the calibration frequency for wind sensors was increased to 6 months, following the ANSI/ANS-3.11-2015 recommendations and the DMCC assist visit recommendations from 2006. This change was due to the increasing dryness of the LANL site and the additional dust in the atmosphere that could impact the bearings of the wind speed and direction sensor.

The LANL Standards and Calibration Laboratory (SCL) reviewed and approved the User Performed Calibration Plan for the Meteorology Monitoring Project (Appendix A). The Meteorology Project calibrates wind and temperature sensors. All other monitoring equipment is sent to SCL for calibration, either by SCL or by a qualified subcontractor. ENV-ES-SOP-5131 "Calibration and Maintenance of Instruments for the Meteorology Monitoring Project" covers wind and temperature instrument calibration in detail.

8.6 Analytical Procedures

Samples are not collected by the Meteorology Project for analytical chemistry evaluation.

8.7 Software Quality

The Meteorology Project data management software, routine data processing, and LANL Weather Machine web presentation were identified as non-safety software, risk (management) level 4 under LANL procedure P1040, Software Quality. The software was migrated to a new UNIX server in FY2014 and a new standard database data storage system will be developed in the future. The OIO organization has

responsibility for documenting the new system following the graded approach for the complexity of this software.

8.8 Data Reduction, Validation, and Reporting

The Meteorology Project purchased dataloggers and datalogger software from Campbell Scientific for the collection of meteorological data. The dataloggers are programmed to convert the instrument electronic signals into meteorological units. The Meteorology Project is in the process of upgrading the project dataloggers to a more modern system. The datalogger programs were tested during FY2015 and are being implemented in FY2016. Procedures are being written to control the use and updates to datalogger software.

Campbell Scientific Loggernet software is used on a PC at TA-54-1001 (meteorology electronics laboratory) to poll each tower or monitoring location every 15 minutes. The tower data are then sent to the Weathernet-prod UNIX server and the data are posted to the web. Graphics are updated every 15 minutes. A range checking program is run every day to identify data beyond normal ranges. An email is sent to the meteorology team with the tower, instrument, day, and time for data falling outside normal ranges. The data are moved from “circular files” to long-term archival storage every 30 days, following data quality review and corrections.

- Automated data checks: meteorological values that fall outside a prescribed range are reassigned non-values. An email is automatically sent to all project personnel alerting them of the details of each automatic data value change. Other checks include comparing 15-minute rainfall totals with 24-hour summary values.
- Manual data check: a meteorologist reviews the most recent 12 hours of data using the chart summaries feature on the Weather Machine on a daily basis. In addition, the meteorologist uses a PV-Wave software program to graphically review meteorological data every week. The high frequency of manual data checks have proven to be key to quickly identifying malfunctioning instruments. When unrealistic values are encountered, all personnel are alerted through the tower data quality assurance (QA) log book. The meteorology data steward manually reassigns data in the archives to missing data codes.
- Automated computer systems data transfer check: An email is automatically sent to all project personnel alerting them of the details of any data transfer issues (e.g., transfer did not occur, transfer occurred late, etc.).
- Manual data check: the Meteorology Instrumentation Technician performs a daily review of data capture information to identify instrumentation issues. The Instrument Technician inspects all instrument sites once per month to identify instrument or safety/security issues.

The LANL Meteorology Project is committed to maintaining a constant stream of high quality weather data and accessibility to those data. A transition from an HP UNIX server (known as WXMach) to a Red Hat UNIX server (known as Weathernet-prod) was completed during CY2014. The data management system is scheduled for upgrades in the future to a more modern database structure. Analysis and graphics software will be updated as necessary following the system upgrade.

The following table lists the procedure followed for data management and accessibility.

Procedure Identifier	Title
EPC-CP-SOP-5160	Routine Meteorological Data Processing

Management Updates: the Meteorology Project Leader regularly updates line management on data quality issues and administrative topics such as budget and activities. In CY2014, the meteorologist began writing annual reviews of data quality. These reports are submitted to management and made available to customers.

Annually, the meteorologists review data completeness and data quality issues. An annual report is prepared to assure that project requirements are met and to document issues and resolutions. The most recent reports are:

- LANL Meteorology Monitoring Project: 2013 Data Completeness/Quality Report (LA-UR-14-2114)
- LANL Meteorology Monitoring Project: 2014 Data Completeness/Quality Report (LA-UR-15-21184)
- LANL Meteorology Monitoring Project: 2015 Data Completeness/Quality Report (in progress)

8.9 Internal Quality Control

Automated data checks: the meteorologists identify meteorological values that fall outside a prescribed range and reassign them non-values. An email is automatically sent to responsible Meteorology Project personnel alerting them of the details of each automatic data value change.

Automated computer systems data transfer check: An email is automatically sent to all project personnel alerting them of the details of any data transfer issues (e.g., transfer did not occur, transfer occurred late, etc.).

Manual data checks: On a daily basis, meteorologists review the most recent 12 hours of data using the chart summaries feature on the Weather Machine. In addition, every week, meteorologists use a PV-Wave software program to graphically review meteorological data. This check is very effective for spotting quality problems quickly. The graphical quality control software shows all tower levels of data simultaneously for each variable, so a malfunctioning instrument at a given level is usually instantly apparent. The high frequency of manual data checks is key to quickly identifying malfunctioning instruments. When unrealistic values are encountered, the data values are manually reassigned non-values and responsible Meteorology Project personnel are alerted through the tower log books.

Manual instrument data checks: On a daily basis, the meteorology instrumentation technician performs a review of data capture information to identify instrumentation issues. Once per month, the Meteorology Instrument Technician inspects all instrument sites to identify and correct instrument or safety/security issues.

Other more specific data checks include comparing 15-minute rainfall totals with 24-hour summary values to assure the correlation of data remains consistent and anomalies are expeditiously addressed.

Section 5.0 lists quality control and improvement activities determined to appropriately address predictive and preventative maintenance.

8.10 Preventive Maintenance

A subcontractor specializing in tower inspection and maintenance inspects all towers annually and performs routine maintenance as required. The program assures the structural integrity of the towers and guy lines. The LANL hoist and carriage program requires an annual instrument boom hoist and carriage inspection and documentation in conjunction with the tower maintenance subcontractor visit, to assure correct operation and maintenance of the instrument boom hoists and carriages.

Manufacturer's guidelines for preventative maintenance of instruments are followed. The Instrument Technician performs and documents a visual inspection of all instruments once a month following procedure EPC-CP-SOP-5100 "Meteorological Tower Hoist and Carriage Operation." Binoculars are used to inspect instrumentation located on tower booms above ground level.

Preventive maintenance is conducted following manufacturer's guidance and EPC procedures. Rain gage funnel surfaces are wiped clean every 6 months. Short- and long-wave radiation sensors are cleaned every month. Temperature radiation shields are annually coated with wax to allow snow to easily shed.

The Meteorology Instrument Technician maintains a spare parts inventory that is periodically checked to assure the availability of calibration equipment, signal cabling, additional sensors in case of instrument failure, etc.

A long-term maintenance plan has been documented to assure appropriate and consistent long-term tower instrumentation performance. This plan is included as Appendix B of this document.

9.0 ASSESSMENTS AND REPORTS TO MANAGEMENT

9.1 Internal Assessments

An internal assessment of the meteorology calibration procedure was conducted in 2013 (OIO-13-001). Beginning in CY2016, the Meteorology Project Leader will conduct and document a review of the Meteorology Project using the DMCC Meteorological Monitoring Project Self-Assessment Tool: http://orise.orau.gov/emi/dmcc/files/2011DMCCAssessmentTool.pdf. This assessment will be submitted to management with proposed corrective actions.

9.2 Independent Assessments

LANL-wide guidance on independent assessment is provided in ISD 328-1.0 "Independent Assessment" and this guidance will be followed by the Meteorology Project.

Periodic system and performance audits of the Meteorology Project are conducted by qualified external entities. Formal reports are submitted to the ADESH records system. The most recent system audit was an evaluation of the whole of the Project (equipment, procedures, training, records, etc.). It was performed by the DMCC in 2015 (DMCC 2015). The most recent performance audit focused on the measurements aspect of the Project and was performed on the TA-54 tower in 2003. The meteorology calibration procedure was independently reviewed in 2013 (OIO-13-001).

The LANL Meteorology Project has put a subcontract in place with Sandia National Laboratory to provide assistance to the LANL Meteorology Project. The plan is to have Sandia provide an independent performance audit of our meteorology calibration process. The Sandia Meteorology Instrument Technician is required to provide the subject matter expertise to assess LANL performance of instrument calibration.

9.3 Assessment of Data Precision, Accuracy, and Completeness

Annual assessment of data completeness is evaluated for each instrument at each tower. A report is published on data completeness and includes a discussion of quality issues. This report is provided to EPC Division management and is made available on the LANL Weather Machine to assist data users.

Data accuracy is specified by the instrument, the siting, and data logging process. The instrument accuracy is verified through the periodic calibration process.

At this time, we do not co-locate instruments in the field to determine data precision.

The accuracy of the meteorology data is verified through the instrument calibration program (Appendix A) and through periodic reviews of tower/instrument siting and specific locations.

9.4 Corrective Actions

LANL uses procedure P330-6, Nonconformance Reporting, to document the disposition of sensors and data that do not meet meteorology requirements. Corrective actions are tracked using the Performance Feedback and Improvement Tracking System (PFITS) to track completion and closeout of corrective actions.

9.5 QA Reports to Management

The annual data completeness and quality assessment of all meteorological data are provided to management. The report identifies issues that negatively impact data quality and completeness.

10.0 REFERENCES

- ANSI 2015: ANSI/ANS-3.11-2015, “American National Standard for Determining Meteorological Information at Nuclear Facilities.”
- DMCC 2015: DOE Meteorology Coordinating Council, “Meteorological Project Follow-Up Assist Visit,” August 20-21, 2015.
- DOE 2011: US Department of Energy, “Radiation Protection of the Public and the Environment,” DOE Order 458.1 (June 2011).
- DOE 2005: US Department of Energy, “Comprehensive Emergency Management System,” DOE Order 151.1 (November 2005).
- DOE 2015: US Department of Energy Handbook, “Environmental Radiological Effluent Monitoring and Environmental Surveillance,” HDBK-1216-2015, 2015.
- EPA 2000: US Environmental Protection Agency, “Meteorological Monitoring Guidance for Regulatory Modeling Applications,” EPA-454/R-99-005/
- EPA 2002: US Environmental Protection Agency “Guidance for Quality Assurance Project Plans,” EPA QA/G-5.
- Lee et al. 1994: J. T. Lee, J. Archuleta, and D. Hoard, “Evaluation of a Diagnostic Wind Field Model for the Los Alamos Area,” Los Alamos National Laboratory document LA-UR-94-3587.

11.0 APPENDICES

Appendix A: Meteorology User Performed Calibration Plan

Appendix B: Long-Term Maintenance Plan

Appendix C: Meteorology System Accuracy Documentation

Appendix D: Routine Meteorology Project Customers

APPENDIX A: METEOROLOGY USER PERFORMED CALIBRATION PLAN

Los Alamos NATIONAL LABORATORY EST 1943

Effective Date: 1/25/2016 Next Review Date: 1/25/2018

Environment, Safety, Health Directorate

Environmental Protection – Compliance Programs

User Calibration Plan – Meteorology Monitoring (VAR-2014-02)

Reviewers:

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CONTOLLED DOCUMENT

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User Performed Calibration (UPC)

1.0 INTRODUCTION

This Program Plan describes the requirements for assuring that User Calibrations performed by the meteorology monitoring program at Los Alamos National Laboratory will result in with sufficient accuracy and traceability in accordance with controlled procedures to support the objectives of the activity. The User Performed Calibration program for meteorology is managed by the Environmental Compliance Programs Group (ENV-CP) which is part of the Environmental Protection Division (ENV).

2.0 PURPOSE

The meteorology program has an integral requirement that systems are operating correctly to support emergency response at LANL. This requirement is implemented through daily and weekly instrument checks – a more frequent requirement than the meteorology program calibration intervals. The program has been staffed to perform these instrument checks. The meteorology instruments to be calibrated in the UPC are wind speed, wind direction, vertical wind speed, and temperature.

3.0 ACRONYMS

ENV	Environmental Protection Division
CP	Compliance Programs Group
ANSI	American National Standards Institute
S&CL	Standards and Calibration Laboratory
EPA	Environmental Protection Agency
NCR	Nonconformance report
SOP	standard operating procedure
QP	quality procedure
N/A	not applicable

4.0 IMPLEMENTATION

4.1 Document Control

ENV-DO-QP, Document Control, is the local document control process and procedure that meet P1020-2, *Laboratory Document Control.*

4.2 Records Management

ENV-DO-QP-110, Records Management, is the local Records Management process and procedure for the identification, collection, retention, indexing, access, filing, storage, maintenance, and disposal of quality and technical records associated with the UPC Program that meet P1020-1, *Laboratory Records Management.*

4.3 Training

The ENV Division Personnel Training Procedure, ENV-DO-QP-115.1, requires that training requirements for work be documented in ENV Technical Project Plans and implementing procedures. ENV-CP ensures the competence of ENV-CP personnel to perform calibrations by hiring individuals that meet the qualification requirements listed in the Technical Project Plan for Meteorological Monitoring (WES-PLAN-300).

All employees must train to the applicable calibration procedures prior to performing work. The meteorology instrument technician must train to ENV-ES-SOP-5131, "Calibration, Refurbishment, & Maintenance of Meteorology Program Equipment. In addition, the meteorology instrument technician must obtain all safety related training identified in the IWDs covering meteorology instrumentation work. All training is documented in the LANL U-train system.

4.4 Implementing Procedures

The plan and procedure required for all UPC activities (i.e., calibration, Outsource calibration certificate reviews, outsourcing processes, MAP Activities, etc.) are: ENV-ES-SOP-5131, "Calibration, Refurbishment, & Maintenance of Meteorology Program Equipment," ENV-PLAN-300, "Technical Project Plan for Meteorological Monitoring."

4.5 Assuring the Quality of the Calibration

ENV-ES-SOP-5131 was independently reviewed by a technically qualified expert, to assure conformance to manufacturer's requirements (OIO-13-001, November 2013). The procedure was updated to address the review.

Each calibration report (i.e. forms generated through the use of ENV-ES-SOP-5131 or prepared by an outside supplier) is independently reviewed by the meteorologist following Attachment 1. In addition, control charts of calibration results are developed and maintained by the meteorologist, to review the results of calibrations over time.

4.6 Out-of-Tolerance (OOT) and Nonconformance Reporting (NCR)

The required specifications to meet the "as-found" or "as left" configuration are documented for each type instrument in ENV-ES-SOP-5131. For those instruments not meeting these tolerances, a NCR is documented per P330-6, Nonconformance Reporting. The process for determining whether a nonconforming condition exists is documented in the calibration procedure. When an instrument does not meet the tolerances specified in ENV-ES-SOP-5131, a nonconforming conditions exists and an NCR is documented.

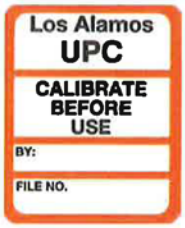
4.7 Inactivation and Closing the Calibration

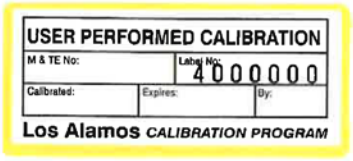
The process for determining whether a nonconforming condition exists is documented in the calibration procedure ENV-ES-SOP-5131. When an instrument does not meet the tolerances specified in ENV-ES-SOP-5131, a nonconforming conditions exists and an NCR is documented using the LANL Institutional NCR process.

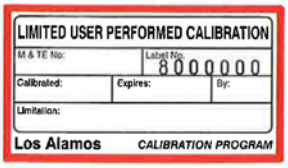
4.8 UPC Label Control

The meteorology instrument technician obtains UPC labels from the S&CL. ENV-CP maintains a calibration tracking list and logs UPC labels as part of the tracking list. The only labels used in the UPC meteorology program are User Performed Calibration and calibration expired or inactive stickers as depicted below.

User-Performed Calibration (UPC), ENV-CP Meteorology







4.9 Software Quality Management

Campbell Scientific dataloggers are used in the calibration process, to record results. The datalogger program is documented and controlled through the ENV-ES-SOP-5131. The only calculations done in the datalogger are to convert units of measurement (e.g. voltage) to meteorology units (e.g. azimuth).

4.10 Calibration/ Reference Standards

The standards used in the calibration process are listed below, including the list of standards, calibration source, and calibration interval.

Table 1.0 – Calibration / Reference Standards

Equipment	Function/Where Used	Calibrated/Verified Interval	Source of Calibration
Model 18310 Torque Disc R.M. Young	Used to verify the start-up threshold torque for the horizontal and vertical RM Young Anemometers	Verified/Calibrated -No User Selectable Weights Replace if Damaged	N/A
Model 18331 Vane Torque Gauge R.M. Young	Used to verify the Horizontal Anemometer Vane (Directional Rotation/Azimuth) Torque	Verified/Calibrated-Yes Annually	S&CL
Model 18112 Vane Angle Fixture R.M. Young	Used to verify the Horizontal Anemometer Vane Angle Transducer Output Signal to Azimuth & to make setting adjustments	Verified/Calibrated-No Fixed Value References	N/A
Model 18802 RM Young Anemometer Drive	Used to verify the Horizontal and Vertical Anemometer Wind Speed Transducer Output Signals variable from 200 to 15,000rpm in 100 rpm increments	Verified/Calibrated –Yes Annually	S&CL
Model 18801 Fixed RM Young Anemometer Drive	Used to verify the Horizontal and Vertical Anemometer Wind Speed Transducer Output Signals variable from 100 to 10,000rpm in 1-rpm increments	Verified/Calibrated –Yes Annually	S&CL
Fixed 300RPM RM Young Anemometer Drive	Used to verify the Horizontal and Vertical Anemometer Wind Speed Transducer Output Signals	Verified/Calibrated –Yes 5-year cycle	S&CL
Fixed 1800RPM RM Young Anemometer Drive	Used to verify the Horizontal and Vertical Anemometer Wind Speed Transducer Output Signals	Verified/Calibrated –Yes 5-year cycle	S&CL
Fixed 3600RPM RM Young Anemometer Drive	Used to verify the Horizontal and Vertical Anemometer Wind Speed Transducer Output Signals	Verified/Calibrated –Yes 5-year cycle	S&CL

User-Performed Calibration (UPC), ENV-CP Meteorology

Equipment	Function/Where Used	Calibrated/Verified Interval	Source of Calibration
Model 87V Handheld Fluke Multimeter	Used to verify resistance and DC voltage measurements during temperature sensor , horizontal & vertical anemometer verifications (as appropriate)	Verified/Calibrated –Yes Annually	S&CL
Model 177 Handheld Fluke Multimeter	Used to verify resistance and DC voltage measurements during temperature sensor , horizontal & vertical anemometer verifications (as appropriate)	Verified/Calibrated –Yes Annually	S&CL
Model 8846A Fluke Precision Multimeter	Used to verify resistance and DC voltage measurements during temperature sensor , horizontal & vertical anemometer verifications (as appropriate)	Verified/Calibrated –Yes Annually	S&CL
Model 884X-RTD Fluke Platinum RTD Thermometer	Used to verify the ambient air temperature monitoring sensors (060A-*) outputs during test	Verified/Calibrated – Yes Annually	S&CL
Campbell Scientific 21X Data Logger	Interface Device between Laptop Computer & Horizontal Anemometers Under Test; processes sensor input readings	Verified/Calibrated – Yes –	S&CL sends to Campbell Scientific every other year

4.11 Calibration Intervals

Calibration intervals are based on the manufacturer's specifications for each sensor type. The meteorology program is documenting instrument performance in control charts.

The meteorology program has identified that horizontal and vertical wind speed and horizontal wind direction may be impacted by an increase in ambient dustiness, due to long term drought conditions at Los Alamos. During FY14, wind instrument calibration frequency has been increased over manufacturer's specifications. Calibration data will be charted and reviewed to determine if more frequent calibration is required.

4.12 Calibration Recall System

The meteorology instrument tracking spreadsheet is used to track calibration dates. The meteorology instrument technician reviews the tracking list, to identify upcoming calibration requirements and schedules the calibrations. The calibration schedule is reviewed with the meteorologist monthly.

4.13 Uncertainty and Traceability

Overall system uncertainty requirements for wind speed, direction, and temperature and defined by the ANSI-3.11-2015, and published in DOE Handbook on Environmental Radiological Effluent Monitoring and Equipment (2015). Uncertainties in LANL meteorological measurements have been identified following the manufacturers estimates of accuracy, user experience in data management uncertainties, and the examples provided in ANSI-3.11-2015 and DOE 2015.

Temperature Measurement Uncertainty:

Sensor = 0.19 °C (MetOne)

Aspirators = 0.03 °C (MetOne)

Datalogger analog to digital conversion = 0.05 °C (Campbell Scientific)

Calibration equipment = 0.05 °C (Fluke platinum thermometer)

Loggernet transmission to server (rounding) = 0.019 °C (estimated as 10% of sensor uncertainty)

Storage in server (rounding) = 0.019 °C (estimated as 10% of sensor uncertainty)

RSS Error = 0.207 °C

DOE requ't = 0.5 °C

Meets? = Yes

Horizontal Wind Speed Measurement Uncertainty:

Sensor = +/- 0.2 m/s or 1% of reading (RM Young Sensor)

Analog to digital conversion = +/- 2.315 10^{-3} of the horizontal speed (Campbell Scientific)

Calibration equipment = 0.0005 m/sec (RM Young)

Loggernet transmission to server (rounding) = estimated as 10% of sensor uncertainty

Storage in server (rounding) = estimated as 10% of sensor uncertainty

User-Performed Calibration (UPC), ENV-CP Meteorology

Table 2.0 – Horizontal Wind Speed Uncertainty

Speed	Accuracy of sensor	Calib Equip	Datalogger Analog to Digital	Data Transmission to server/ Server storage	RSS Error	DOE Required Accuracy	Meets DOE Specific
0.4	0.2	0.0005	$9.3\ 10^{-6}$	0.02/0.02	0.202	0.22	Yes
1.0	0.2	0.0005	$2.3\ 10^{-5}$	0.02/0.02	0.202	0.22	Yes
2.0	0.2	0.0005	$4.6\ 10^{-5}$	0.02/0.02	0.202	0.22	Yes
4.0	0.04	0.0005	$9.3\ 10^{-5}$	0.004/0.004	0.040	0.20	Yes
8.0	0.08	0.0005	$1.9\ 10^{-4}$	0.008/0.008	0.081	0.40	Yes
16.0	0.16	0.0005	$3.7\ 10^{-4}$	0.016/0.016	0.162	0.80	Yes
32.0	0.32	0.0005	$7.4\ 10^{-4}$	0.032/0.032	0.323	1.60	Yes
64.0	0.64	0.0005	$1.5\ 10^{-3}$	0.064/0.064	0.646	3.20	Yes

Horizontal Wind Direction Measurement Uncertainty:

Sensor = 3 degrees (RM Young)

Datalogger analog to digital conversion = 0.36 degrees (Campbell Scientific)

Calibration equipment = 0.5 degrees

Loggernet transmission to server (rounding) = 0.3 degrees (estimated as 10% of sensor uncertainty)

Storage in server (rounding) = 0.3 degrees (estimated as 10% of sensor uncertainty)

RSS Error = 3.092 degrees

DOE requ't = 5 degrees

Meets? = Yes

Vertical Wind Speed Measurement Uncertainty:

RM Young Sensor is Accurate to +/- 0.25 m/sec

RSS Error = 0.126

DOE requ't = N/A

The test uncertainty ratio is documented as follows:

Table 3.0 - TUR

Meteorology Measurement	Probe Accuracy	Calibration Equipment Accuracy	Test/Uncertainty Ratio
Temperature	0.19 °C	0.05 °C	3.8:1
Horizontal Wind Speed	0.2 m/sec	0.0005 m/sec	400:1
Horizontal Wind Direction	3 degrees	0.5 degrees	6:1
Vertical Wind Speed	+/-0.25 m/sec	0.0005 m/sec	500:1

The Test Uncertainty Ratio for wind speed (horizontal and vertical) and wind direction are larger than the LANL requirement. Although the Test Uncertainty ratio for the calibration of temperature probes does not meet the LANL standard value of 4, the temperature probes are much more accurate than the DOE system requirements. Purchase of a more accurate temperature sensor for additional calibration sensitivity is not warranted.

The traceability of each calibration is documented on the ENV-ES-SOP-5131 calibration forms. The specific equipment used in the calibration and the equipment calibration dates are recorded.

4.14 Environmental Conditions

Wind speed and direction calibrations are performed at the TA-54-1001 laboratory. These indoor conditions are sufficient to accurately calibrate wind sensors.

Temperature calibrations are performed at the TA-54-1001 laboratory. Temperature sensors are calibrated using liquid baths at specified temperatures. The calibration standard is used to verify the bath temperature and the stability of the bath temperatures. Environmental conditions may include: biological sterility, dust, electromagnetic disturbances, and radiation, humidity, temperature, and sound and vibration levels.

4.15 Equipment

All equipment used in calibration meteorology instruments in controlled by the ENV-CP meteorology program. All calibration equipment is tracked in the calibration tracking list; the calibration list is checked each month, to assure that all calibration equipment is in calibration when used. All calibration equipment is tracked using an S&CL assigned number.

All calibration equipment and manuals are stored at TA-54-1001. Only ENV-CP employees are allowed unescorted access to TA-54-1001, to assure that calibration equipment are not tampered with.

A listing of all calibration equipment is presented in Section 4.10.

4.16 Calibration Reporting

ENV-ES-SOP-5131, "Calibration and Maintenance of Instruments for the Meteorology Monitoring Project" is the calibration procedure used to document the results of each calibration accurately, clearly, unambiguously, and objectively.

4.17 Subcontracted Calibration and Report Reviews

Identify when the UPC may be required to use an ISO 17025 accredited calibration subcontractor, or a NNSA Nuclear Weapons Complex Site rather than a subcontractor approved through a QPA-DO assessment (if applicable). As necessary, ENV-CP will work with QPA-DO to have unapproved sources evaluated and placed on the IESL.

Standards or reference materials used for the calibration of data loggers, pressure, solar radiation, and humidity sensors are calibrated by S&CL or are sent out to calibration suppliers by S&CL.

When ENV-CP receives results from these laboratories, the instrument technician reviews the reports and updates the Master Equipment tracking list with calibration dates. The reports are reviewed to assure that the instrument successfully met instrument accuracy requirements. The review is documented using Attachment 1.

4.18 Reference Materials

Identify the process of verification on procured reference materials. Reference materials (in this case, calibration equipment) are procured using standard LANL purchasing process. Calibration equipment is procured using Quality Assurance Supplement Form 838c to identify the specifications. Wind speed and direction calibration equipment must be procured from the manufacturer (RM Young) for compatibility with RM Young wind speed and direction sensors. Platinum resistance thermometers used in calibrations are purchased from Fluke.

4.19 Measurement Assurance Program (MAP)

Meteorology data are reviewed on a daily basis, to assure that data are being successfully collected. Meteorology data are automatically reviewed daily to assure that data are within known, appropriate meteorology ranges. Daily screening of the data is done by both the meteorologist and the instrument technician to identify obvious data outliers.

All meteorology data are reviewed in detail by a meteorologist within 7 to 10 days of collection. The data are reviewed using graphics software which plots meteorology data versus time. Parameters are plotted so that data from different tower levels can be compared and are plotted so that meteorology consistency can be checked (e.g. higher humidity values are associated with rain events).

Instrument issues are identified by the meteorologist or by the instrument technician are documented via email and the instrument technician schedules instrument replacement (field repair is typically not feasible). Bad data are identified and removed from the long term data archive.

An annual data quality report is written by the meteorologist (beginning in CY14), to document instrument performance. Data completeness is documented and data issues are documented.

4.20 Use of a Calibration Supplier not on the IESL

Calibration suppliers which are not on the LANL IESL are approved by S&CL and are identified as compliant calibrations. These suppliers calibrate dataloggers, pressure sensors, and solar radiation instruments as there are no known suppliers which qualify for the LANL IESL.

User-Performed Calibration (UPC), ENV-CP Meteorology

Attachment 1: Review of Calibration Reports

Name of Calibration Report: _____

Date of Calibration Reports: _____

Calibration Report Reviewed By: _____ Date _____

Requirement	Met	Does not meet	Follow up action
Identification of Customer			
Unique M&TE number			
Identification of procedure used in calibration			
description of, the condition of, and unambiguous identification of the item(s) calibrated			
date(s) of performance of the calibration			
"as-found" and "as-left" data;			
Calibration results with units of measurement			
Name, Z#, signature and date identifying the person(s) conducting the calibration			
Name, Z#, signature and date identifying the person(s) authorizing the calibration			
Statement of compliance/non-compliance with requirements and/or specifications			
Level 0			
Level 1			
Level 2			
Level 3			
Level 4			
Conditions under which the calibrations were made that have an influence on the measurement results			
Evidence that the measurements are traceable (a listing of standards used)			
Calibration interval and calibration expiration date			
NCR required?			
Notes			

Technical Project Plan for Meteorology: Appendix A
ENV-CP Meteorology UPC Program Plan, R0

APPENDIX B: LONG-TERM MAINTENANCE PLAN

The tower sites are listed below in order of monitoring/need importance. A map showing their locations is provided as Figure 1 on page 3.

Priority	Monitoring Site
1	TA-6
1	TA-54
2	TA-53
2	TA-49
2	TA-5 (MDCN)
3	NCOM

The service/maintenance items listed below for each tower are based upon physical assessments at each site along with annual inspection findings from Phoenix Tower Service and requirements directed in the LANL Institutional policies and procedures for Tower & Hoisting/Lifting Equipment.

Towers with elevator or hoist type systems are: (TA-6, TA-54, TA-53, and TA-49)
Tilt capable towers: (TA-5)

TA-6

1. Tower Structure, Paint, and Guy Wire Tensioning/ Inspections: Checked Annually by tower maintenance subcontractor; painted as necessary to meet requirements.
2. Tower Warning Beacon Lights: Checked annually by tower maintenance subcontractor; replaced as needed.
3. Hoist/Carriage System:
    a. Non-Operational Inspection monthly & inspected prior to each operation event.
    b. Annual Inspection by LANL Hoist Inspectors
    c. Gearbox Lubrication Replacement: (Due FY2016) Replace every 3 years unless use increases; per agreement with LANL tower hoist inspectors.
    d. Drive Unit: Replace V-Belt every 4 years, (Due FY2016) monitor belt for cracking.
    e. Elevator Carriage Cable: (Replaced in FY2013) included in monthly and pre-op inspections; should be good for 10+ year's normal operation.
    f. Elevator Sheaves (Pulley's): (Changed in FY2012) Annual Inspection Item; should be changed when wear dictates, possibly due in 5 years (FY2017).
    g. Carriage System Control Panel Lights: Inspect during each use of tower hoist.
4. Communications System: Due to the change to LANL telephone systems to Voice over Internet Protocol (VOIP), we will upgrade our data communications to DSL during FY2016.
5. TA6 Snow Depth Station: maintenance issues in-process FY2014.
6. Solar Radiation Station: Replace all cabling; projected for FY2016 to accommodate updated approach to instrument measurements.

TA-54

1. Tower Structure, Paint, and Guy Wire Tensioning/ Inspections: Checked annually by tower maintenance subcontractor; painted as necessary to meet requirements.
2. Tower Warning Beacon Lights: Checked annually by tower maintenance subcontractor; replaced as needed.
3. Hoist/Carriage System:
    a. Non-Operational Inspection monthly & inspected prior to each operation event.
    b. Annual Inspection by LANL Hoist Inspectors
    c. Gearbox Lubrication Replacement: (Due FY2016) Replace every 3 years unless use increases; per agreement with LANL hoist inspector.
    d. Drive Unit: Replace V-Belt every 4 years, monitor belt for cracking. Drive Unit S/B ok barring a catastrophic failure.
    e. Elevator Carriage Cable: cable inspection included in monthly and pre-op inspections; cable is older but shows no signs requiring change; when replaced it should be good for 10+ year's normal operation.
    f. Elevator Sheaves (Pulley's): (Changed in FY2012) Annual Inspection Item; should be changed when wear dictates, possibly due in 5 years (FY2017).
    g. Carriage System Control Panel Lights: inspect at each use.

TA-53

1. Tower Structure, Paint, and Guy Wire Tensioning/ Inspections: Checked annually by tower maintenance subcontractor; painted as necessary to meet requirements.
2. Tower Warning Beacon Lights: Checked annually by tower maintenance subcontractor. Light was replaced in FY2012; lights are replaced as needed.
3. Hoist/Carriage System:
    a. Non-Operational Inspection monthly & inspected to each operation event.
    b. Annual Inspection by LANL Hoist Inspectors
    c. Gearbox Lubrication Replacement: (Due FY2016) Replace every 3 years unless use increases; per agreement with LANL hoist inspector.
    d. Drive Unit: Replace V-Belt every 4 years, monitor belt for cracking. Drive Unit S/B ok barring a catastrophic failure.
    e. Elevator Carriage Cable: cable inspection included in monthly and pre-op inspections; cable is older but shows no signs requiring change; when replaced it should be good for 10+ year's normal operation.
    f. Elevator Sheaves (Pulley's): (Changed in FY2012) Annual Inspection Item; should be changed when wear dictates, possibly due in 5 years (FY2017).
    g. Carriage System Control Panel Lights: All Lights working as of last function.

TA-49

1. Tower Structure, Paint, and Guy Wire Tensioning/ Inspections: Checked annually by tower maintenance subcontractor; painted as necessary to meet requirements.
2. Tower Warning Beacon Lights: Checked annually by tower maintenance subcontractor; replaced as needed.
3. Hoist/Carriage System:
    a. Non-Operational Inspection monthly & inspect prior to each operation event.
    b. Annual Inspection by LANL Hoist Inspectors
    c. Gearbox Lubrication Replacement: (Due FY2016) Replace every 3 years unless use increases; per agreement with LANL hoist inspector.
    d. Drive Unit new in FY2013: Replace Cogged Drive Belt every 4 years, monitor belt for cracking. Drive Unit S/B ok barring a catastrophic failure.
    e. Elevator Carriage Cable: (Replaced in FY2013) included in monthly and pre-op inspections; should be good for 10+ year's normal operation.
    f. Elevator Sheaves (Pulley's): (Due FY2017) Annual Inspection Item; should be changed when wear dictates, possibly at 5-year intervals.

4. Tower Base Junction box Enclosure on Tower is rusting/very corroded; unknown cost to replace due to extensive wiring located in enclosure; continue to monitor, possibly seek quotation on work.
5. Tower needs to be transitioned to 24Vdc Aspiration fans from the now existing 120Vac Aspiration fans as noted in an earlier (I believe 2009 Electrical Safety PFITS Item). Change may require additional MSS Resources for underground conduit installation and cable pulling; plus purchase of cabling. More planning needed.

TA-05 (MDCN)

1. Tilt Over 10-Meter Tower: Annual Inspection
2. Tilt Over Hand Crank System:
    a. Inspect monthly & inspect prior to each operation event.
    b. Annual hoist inspection is not necessary assembly does not fall under the existing LANL definition of hoisting/lifting. Wire Rope/Cable & Hand Crank: (Hand Crank Replaced FY2012) unit is included in monthly and pre-op inspections; should be good for 15+ year's normal operation. Hand crank tilt-over assist system is an option and is not necessary to work on tower.
3. Sensor/Equipment Mounting Assembly at top needs to be reworked for a more secure installation (now using RTV & Friction Fit) does not appear to be urgent.

NCOM (Old Fire Station on Arkansas Street)

1. Roof Mounted Heated Tipping Bucket Rain Gauge (Very Low Priority Installation)
2. Access: Instrument is Roof Mounted; access to this roof by LANL personnel is not permitted, we are required to solicit keys from LA County and have county employees do any roof work.
3. Data Logger is situated at the rear of the facility in the basement portion.
4. Initial assessment in 2010 viewed installation as hap-hazard and may have other concerns.

APPENDIX C: METEOROLOGY SYSTEM ACCURACY DOCUMENTATION

Los Alamos NATIONAL LABORATORY EST.1943

memorandum

Environmental Protection & Compliance Division
Environmental Compliance Programs (EPC-CP)

To/MS: Steven L. Story, EPC-CP, (E-File)
David A. Bruggeman, EPC-CP
Gregory T. Stanton, EPC-CP
From/MS: Jean M. Dewart, EPC-CP, (E-File) JMD
Phone/Fax: 5-0239
Symbol: EPC-DO-16-070
Date: March 14, 2016

Subject: Uncertainties of Meteorology Measurements

The DOE Handbook on Environmental Radiological Effluent Monitoring and Environmental Surveillance (DOE 2015) and the ANSI/ANS Standard on Determining Meteorological Information at Nuclear Facilities (ANSI/ANS 2015) call for documentation of the meteorological monitoring uncertainties to assure conformance with DOE and ANSI specifications. Typically, the greatest uncertainty is attributable to the specific sensor and other factors such as data handling and calibration uncertainties are small. However, in response to the DOE Meteorology Coordinating Council recommendations (DMCC 2015), a full documentation of the uncertainties of our LANL meteorology measurements builds confidence in our ability to meet requirements. This memo documents our current understanding of the uncertainties of our measurements and their conformance to requirements. Instrument uncertainties have been obtained from the manufacturers and data management uncertainties have been obtained from the Environmental Protection Agency and/or from professional judgement.

Temperature Measurement Uncertainty

Sensor = 0.19 °C (Met One)
Aspirator = 0.03 °C (Met One)
Datalogger analog to digital conversion = 0.05 °C (Campbell Scientific)
Loggernet transmission to server (rounding) = 0.019 °C (estimated as 10% of sensor uncertainty)
Storage in server (rounding) = 0.019 °C (estimated as 10% of sensor uncertainty)
RSS Error = 0.207 °C
DOE requirement = 0.5 °C
Meets? Yes

Horizontal Wind Speed Measurement Uncertainty

Sensor = +/- 0.2 m/s or 1% of reading (RM Young Sensor)
Analog to digital conversion = +/- 2.315 10^{-3} of the horizontal speed (Campbell Scientific)
Calibration equipment = 0.0005 m/sec (RM Young)
Loggernet transmission to server (rounding) = estimated as 10% of sensor uncertainty
Storage in server (rounding) = estimated as 10% of sensor uncertainty

Speed	Accuracy of sensor	Calib Equip	Datalogger Analog to Digital	Data Transmission to server/ Server storage	RSS Error	DOE Required Accuracy	Meets DOE Specific
0.4	0.2	0.0005	$9.3\ 10^{-6}$	0.02/0.02	0.202	0.22	Yes
1.0	0.2	0.0005	$2.3\ 10^{-5}$	0.02/0.02	0.202	0.22	Yes
2.0	0.2	0.0005	$4.6\ 10^{-5}$	0.02/0.02	0.202	0.22	Yes
4.0	0.04	0.0005	$9.3\ 10^{-5}$	0.004/0.004	0.040	0.20	Yes
8.0	0.08	0.0005	$1.9\ 10^{-4}$	0.008/0.008	0.081	0.40	Yes
16.0	0.16	0.0005	$3.7\ 10^{-4}$	0.016/0.016	0.162	0.80	Yes
32.0	0.32	0.0005	$7.4\ 10^{-4}$	0.032/0.032	0.323	1.60	Yes
64.0	0.64	0.0005	$1.5\ 10^{-3}$	0.064/0.064	0.646	3.20	Yes

Horizontal Wind Direction Measurement Uncertainty

Sensor = 3 degrees (RM Young)
Datalogger analog to digital conversion = 0.36 degrees (Campbell Scientific)
Mounting on boom = 1 degree (periodically confirmed in the field)
Calibration equipment = 0.5 degrees (RM Young)
Loggernet transmission to server (rounding) = 0.3 degrees (estimated as 10% of sensor uncertainty)
Storage in server (rounding) = 0.3 degrees (estimated as 10% of sensor uncertainty)
RSS Error = 3.250 degrees
DOE requirement = 5 degrees
Meets? Yes

Rain Gage

Sensor = 0.5% at 0.5" per hour = 0.0025 inches (All Weather)
Datalogger analog to digital conversion = 0.00001157 inches (Campbell Scientific)
Calibration Equipment = 0.002 inches
Loggernet transmission to server (rounding) = 0.00025 inches (estimated as 10% of sensor uncertainty)
Storage in server (rounding) = 0.00025 inches (estimated as 10% of sensor uncertainty)
RSS Error = 0.003 inches
ANSI requirement = 0.01 inches
Meets? Yes

Pressure

Sensor = 0.55 mb (Setra)
Datalogger analog to digital converstion = 1.1 mb (Campbell Scientific)
Calibration equipment = +/-0.10 mb (provided by Standards and Calibration Lab)

Loggernet transmission to server (rounding) = 0.055 mb (estimated as 10% of sensor uncertainty)
Storage in server (rounding) = 0.055 mb (estimated as 10% of sensor uncertainty)
RSS Error = 1.236 mb
DOE requirement = 3 mb
Meets? Yes

Relative Humidity

Sensor = 1.5% (Rotronic)
Datalogger analog to digital converstion = 0.1 % (Campbell Scientific)
Calibration equipment = +/-0.5% (provided by Standards and Calibration Lab)
Loggernet transmission to server (rounding) = 0.15 % (estimated as 10% of sensor uncertainty)
Storage in server (rounding) = 0.15 % (estimated as 10% of sensor uncertainty)
RSS Error = 1.584 %
DOE requirement = 4 %
Meets? Yes

Solar Radiation

Sensor = 2 W/m^2 (Eppley)
Datalogger analog to digital conversion = 0.1 W/m^2 (Campbell Scientific)
Calibration equipment = +/-0.91% W/m^2 (provided by Standards and Calibration Lab)
Loggernet transmission to server (rounding) = 0.2 W/m^2 (estimated as 10% of sensor uncertainty)
Storage in server (rounding) = 0.2 W/m^2 (estimated as 10% of sensor uncertainty)
RSS Error = 2.218 W/m^2
DOE requirement = 5 W/m^2
Meets? Yes

Longwave Radiation

Sensor = 1 W/m^2 (Eppley)
Datalogger analog to digital conversion = 0.1 W/m^2 (Campbell Scientific)
Calibration equipment = +/-0.91% W/m^2 (provided by Standards and Calibration Lab)
Loggernet transmission to server (rounding) = 0.1 W/m^2 (estimated as 10% of sensor uncertainty)
Storage in server (rounding) = 0.1 W/m^2 (estimated as 10% of sensor uncertainty)
RSS Error = 1.363 W/m^2
DOE requirement = 5 W/m^2
Meets? Yes

References

ANSI 2015: ANSI/ANS-3.11-2015, "American National Standard for Determining Meteorological Information at Nuclear Facilities".

DMCC 2015: DOE Meteorology Coordinating Council, "Meteorological Program Follow-Up Assist Visit".

DOE 2015: DOE Handbook, "Environmental Radiological Effluent Monitoring and Environmental Surveillance," DOE-HDBK-1216-2015.

JMD/lm

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locatesteam@lanl.gov, (E-File)
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APPENDIX D: ROUTINE METEOROLOGY PROJECT CUSTOMERS

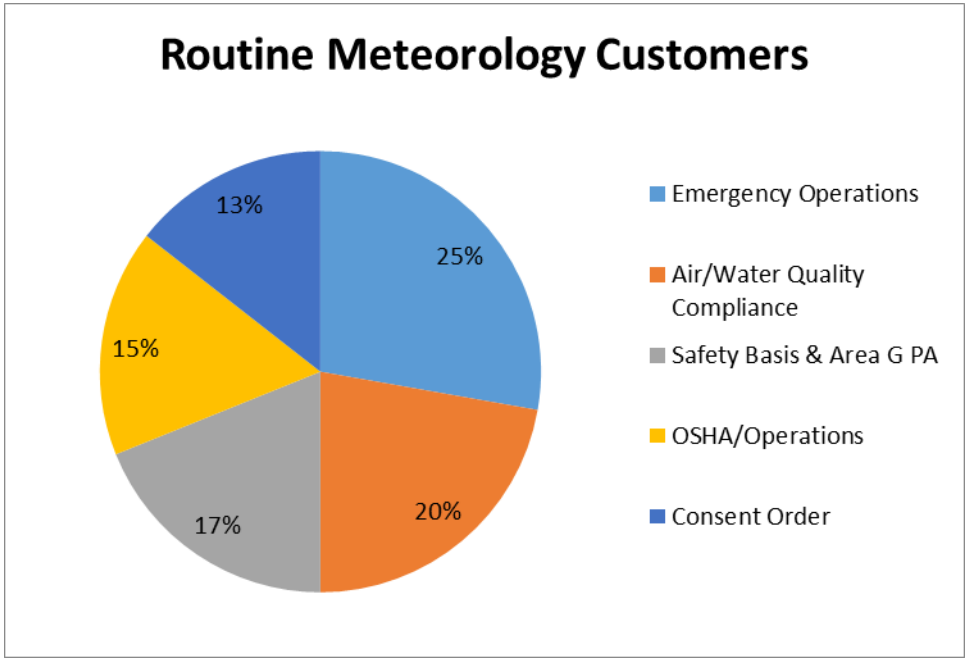
Data Customer	Driver/Requirement	Meteorology Parameters
LLNL NARAC – National Atmospheric Release Advisory Capability	DOE Order 151 This is the real-time atmospheric dispersion modeling requirement DOE-wide	Wind speed and direction at all met towers at all available levels Temperature at all met towers at all available levels Planned NARAC upgrades include using standard deviations of wind speed, direction, and vertical velocity
LANL Emergency Operations Center (EOC) – emergency response	DOE Order 151 This is the back-up, real-time, on-site atmospheric dispersion modeling capability	Wind speed and direction, vertical velocity, standard deviation of all wind speeds and direction, temperature, dew point, and humidity from all met towers at all available levels In addition, solar radiation data are used when atmospheric dispersion models are run locally by an operator
LANL EOC – fire danger	Real time fuel moisture and wind speed measurements to support daily fire danger rating for LANL	10-hour fuel moisture value and wind speed measured every 15 minutes
LANL Rad NESHAP project	40 CFR 61 Subpart H Model the annual off-site dose to the Maximum Exposed Individual based on annual radioactive stack air emissions.	Wind speed, direction, stability class, pressure
AIRNET	40 CFR 61 Subpart H Correcting ambient tritium measurements based on absolute humidity (concentrations can be underestimated w/o this correction)	Temperature, relative humidity, and pressure are used to calculate absolute humidity on a 15-minute basis. The data are averaged over the four meteorology towers for 1 week and provided to AIRNET via automated email.
LANL Safety Basis office – nuclear facility Documented Safety Analyses	10 CFR 830 Nuclear Safety Management. Updated 2008 – 2012 meteorology to calculate 95% accident meteorology for LANL nuclear facilities/DOE Standard 3009	Wind speed, direction, stability

Data Customer	Driver/Requirement	Meteorology Parameters
LANL Environmental Restoration Program	All the work and reports related to NMED Consent Order deliverables presenting water-level data Ambient pressure measurements are required to interpret groundwater monitoring well water level measurements	Barometric pressure data is utilized on a 15-minute increment Precipitation Data –hourly basis
LANL Environmental Restoration Program	Consent Order – especially for conceptual model development and site closure (design criteria) Data are used to predict infiltration rates, groundwater transport models, erosion studies, cover design	Precipitation, temperature, wind speed and direction, solar radiation [15-minute/daily/hourly]
Stormwater Individual Permit for SWMUs/AOCs	NPDES Permit NM0030759 Real time rainfall rates year-round. These data are used to identify SMA ISCOs that may have collected a runoff sample and for BMP inspection purposes, thus meeting the stormwater individual permit requirements.	15-minute rainfall from five LANL stations
Los Alamos/Pueblo Canyons Monitoring	Consent Order Real time precipitation data is used to identify stormwater discharge gage station ISCOs that may have collected a runoff sample.	15-minute rainfall from five LANL stations
Stormwater construction general permit	NPDES Construction General Permit Real time rainfall data are used to determine if site inspections are necessary. Construction sites must be inspected associated within 24 hours of the occurrence of a storm event of 0.25 inches or greater at the nearest meteorology tower.	15-minute rainfall from five LANL stations

Data Customer	Driver/Requirement	Meteorology Parameters
NPDES Permit Programs impacted by NMED Water Quality Standard Attainment decisions	NMAC 20.6.4 Real Time rainfall data coupled with flow data from stream gage stations used to determine hydrological conditions which impact chronic aquatic life attainment decisions. 20.6.4 NMAC	15-minute rainfall from LANL and area stations. *Note: all Parjarito Plateau reaches subject to assessment decisions.*
NPDES Sanitary Sewage Sludge Management Program and Composting Operation	40 CFR Part 503, Permit NM0028355, NMED Solid Waste Regulations and MSGP Storm Water Pollution Prevention Plan Sludge (compost) must attain a certain temperature for 90 days to allow for land application	Temperature
LANL Title V air quality permit	20.2.72 NMAC – Construction Permits Dispersion modeling using on-site meteorological data is required to support each air construction permit application for new or modified sources. Met parameters for smoke measurements	Hourly average wind speed/direction, solar radiation and net radiation, stability class from all tower levels for minimum of one calendar year. Temperatures and wind speeds at time of opacity readings
LANL QPA – ORPS reporting and OSHA investigations	DOE Order 232 Occurrence Reporting/ identify contributing weather factors for incidents	Temperature, rainfall, wind speed and direction
Area G Performance Assessment	DOE Order 435.1 Data are used in transport models of air dispersion, groundwater pathway, and cover erosion	Precipitation, temperature, wind speed and direction, solar radiation [15-minute/daily/hourly]
WX Division	Predict sound impacts to White Rock from HE destruction shots.	Wind speed, direction every 15 minutes at each mesa-top tower at each level, SODAR data for winds/temperatures up to 1000 m above the surface
WX Division	Shock wave experiments	Temperature and pressure data are needed to evaluate high explosives tests
Engineering	Building codes/design basis temperature, wind speeds, precipitation	Temperature, precipitation, RH, wind speeds. Extremes and averages.

Data Customer	Driver/Requirement	Meteorology Parameters
LANL environmental research (EES)	[no regulatory driver] Data for climate change studies and to assess tree mortality from drought effects	Temperature, precipitation, solar radiation, insulation, wind speed, relative humidity
LANL environmental research (EES)	[no regulatory driver] Data for fire effects modeling following both fires – predictions of fire growth and post-fire-sediment transport	Temperature, precipitation, wind speed and direction, relative humidity
LANL UI Division	[no regulatory driver] Snow predictions Temperature data for preparing for extreme weather conditions	Predication on snowfall conditions and expected precipitation, wind speed, temperature Daily high/low temperatures and low temperature predictions
LANL research groups	Calibrated meteorology data for assessing experiments	Temperature, pressure
NEDO project	LANL R&D project from MPA Division. Working with LA County to optimize solar energy delivery/use to/by LANL.	Solar radiation – 15-minute data
WX Division	Study the effects of winds and temperature on acoustic propagation from WX explosions. This supports a variety of programs (IWFO, DOD) on local surveillance of explosions. The data are used to schedule high explosives shots.	Temperature and wind speed

Data Customer	Driver/Requirement	Meteorology Parameters
MESOWest Mesowest.utah.edu/index.html The file we ftp is called: mesowest_service_lanl.dat It contains 15-minute data from TA-6, TA-41, TA-49, TA-53, TA-54, and fuel moisture. See example below.	Good citizen – to support forest fire management by NWS, USFS, BLM	Temperature, wind speed, wind direction, relative humidity speed of wind gusts, pressure, precipitation, snow depth, solar radiation, fuel temperature & moisture 15-minute data are provided
Los Alamos County	Support LA County operations – power generation	Temperature and precipitation to support energy conservation and water conservation projects.
Members of the public in Los Alamos	Good citizen to LANL employee community	All


Routine Meteorology Customers
25%
20%
17%
15%
13%
Emergency Operations
Air/Water Quality Compliance
Safety Basis & Area G PA
OSHA/Operations
Consent Order